

# Water Quality Monitoring Annual Report 2016



## Klondike Watershed

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# Water Quality Objective Monitoring, Klondike River Basin, 2016

## Hydrologic and Geomorphic Characteristics of the Klondike River Drainage Basin

The Klondike River, a major tributary to the Yukon River, drains an area of approximately 7800 square kilometers and has an overall channel length, including the North Klondike River, of approximately 160 Km.

The North Klondike River, a tributary of the Klondike River, drains an area of approximately 1100 square kilometers. From its headwaters in the Ogilvie Mountains, the North Klondike flows in a southerly direction for approximately 75 kilometers until its confluence with the Klondike. It then flows west, down the valley as the Klondike for approximately 42 kilometers until it joins the Yukon River near Dawson. The North Klondike, for its first 58 kilometers, flows through a narrow valley entrenched between high mountains, the remaining length of the Klondike River flows south through relatively flat topography. The banks of the river are stable with relatively little erosion except during flood periods.

Water Survey of Canada's gauging stations are located near the mouth of the north Klondike (09EA004, Km 9.5 Dempster Highway), and at the mouth of the Klondike River (09EA003) near Dawson.

### North Klondike

Topographical drainage Basin	1100 Sq. Kilometers
Area of Lakes	<2%
Area of Forest	<44%
Channel Length	76.5 Kilometers
Terrain	glaciated

### Klondike

Topographical drainage Basin	7800 Sq. Kilometers
Area of Lakes	<1%
Area of Forest	<30%
Channel Length	160 Kilometers
Terrain	Left Limit: non-glaciated Right Limit: glaciated

In 2016, water samples were collected at 20 sites in the Klondike River basin. Sampling commenced on May 19, 2016 and 773 samples were collected up until the end of the season on September 8, 2016. A combination of automatic composite sampling and grab sampling methods were used in the basin. In addition to automated sampling equipment, newly acquired level monitoring instrumentation was installed at three sites, on Bonanza Creek, just upstream of the confluence with the Klondike River and on Hunker Creek, upstream of the highway crossing which is below all mining (BAM), and at the Klondike confluence. This new monitoring equipment has provided us with additional data that correlates with the precipitation data collected via our portable weather stations and has allowed us to derive changes in stream flow and water velocity at these sites.

An additional 176 samples were collected by CMI staff during routine mine inspections.

Atmospheric data was collected using three portable weather stations located at Hunker Creek, North Klondike River and the Klondike River. Additional information was provided through the Yukon Government Community Services weather station at the Klondike Fire Center, located at the Dawson City Airport.

Basin total flow data was provided to us by the Water Survey of Canada station located near the mouth of the Klondike River. Flow data for the individual tributaries to the Klondike River was collected at the time of sampling by the staff of E.M.R CMI using the methodology outlined in the Yukon Placer Secretariat's, Water Quality Monitoring Protocol.

### Site Codes and Global Position of Water Quality Sampling Locations in the Klondike River Watershed

SITE DESCRIPTION	SITE CODE	LATITUDE_DD	LONGITUDE_DD
Klondike River mouth	KL01	64.05348	-139.43961
Klondike River upstream of Bonanza Creek	KL02	64.04311	-139.40936
Klondike River upstream of Hunker Creek	KL03	64.03619	-139.20204
Klondike River downstream of Goring Creek and upstream of Hunker Creek	KL04	64.05810	-139.03092
Klondike River at Dempster Highway	KL05	63.99030	-138.74612
Klondike River downstream of Too Much Gold Creek and upstream of Dempster highway	KL06	63.95778	-138.69030
Klondike River upstream of Too Much Gold Creek	KL07	63.95131	-138.66690
Klondike River at highway washout downstream of Flat Creek	KL08	63.95782	-138.69005
North Klondike River upstream of confluence with Klondike River	KL_NK01	64.00195	-138.59622
Adams Creek mouth	KL_BO_AD01	63.93412	-139.33099
All Gold Creek below all mining	KL_AL01	63.94263	-138.61734
Eldorado Creek mouth	KL_BO_EL01	63.91943	-139.31390
Eldorado Creek Left Fork	KL_BO_EL06	63.86261	-139.24573
Eldorado Creek Right Fork	KL_BO_EL05	63.86261	-139.24573
Eldorado Creek downstream of French Gulch	KL_BO_EL02	63.91267	-139.31483
Eldorado Creek upstream of French Creek	KL_BO_EL03	63.90855	-139.31382
Upper Eldorado Creek background	KL_BO_EL04	63.86187	-139.24578
Flat Creek below all mining	KL_FL01	63.94308	-138.60225
French Gulch mouth	KL_BO_EL_FR01	63.90865	-139.31442
Goldbottom Creek mouth	KL_HU_GO01	63.96433	-138.96706
Last Chance Creek mouth	KL_HU_LA01	64.01050	-139.09091
Too Much Gold Creek mouth	KL_TO01	63.95132	-138.66708
Victoria Gulch mouth	KL_BO_VI01	63.91261	-139.20930
Bonanza Creek below all mining	KL_BO01	64.04054	-139.40814
Lower Bonanza Creek	KL_BO02	64.01295	-139.37022
Lower Bonanza Creek downstream of bridge	KL_BO03	63.97027	-139.35472
Bonanza Creek downstream of Adams Gulch	KL_BO04	63.93550	-139.32798
Bonanza Creek upstream of Adams Gulch	KL_BO05	63.93415	-139.32977
Bonanza Creek downstream of Eldorado Creek	KL_BO06	63.92047	-139.31600
Upper Bonanza Creek upstream of Eldorado Creek	KL_BO07	63.91943	-139.31390
Upper Bonanza Creek upstream of Victoria Gulch	KL_BO08	63.91261	-139.20930
Hunker Creek below all mining	KL_HU01	64.02943	-139.17867
Hunker Creek mouth - most upstream fork	KL_HU01C	64.03619	-139.20204
Hunker Creek mouth fork with multiple channels - larger creek bed	KL_HU01B	64.03592	-139.20201
Hunker Creek mouth behind Fischer's gas station	KL_HU01A	64.03382	-139.20634
Hunker Creek downstream of Henry Gulch	KL_HU02	64.02838	-139.17522
Hunker Creek downstream of Last Chance Creek	KL_HU03	64.01345	-139.09187
Hunker Creek upstream of Last Chance Creek	KL_HU04	64.01050	-139.09091
Hunker Creek downstream of Goldbottom Creek	KL_HU05	63.96918	-138.98291
Hunker Creek upstream of Goldbottom Creek	KL_HU06	64.96433	-138.96706
Hunker Creek above all mining left fork	KL_HU07	63.91105	-138.88522
Hunker Creek right fork	KL_HU08	63.89025	-138.92522
Hunker Creek above all mining and downstream of right and left fork	KL_HU09	63.91503	-138.88501

## **Water Quality Objective monitoring, Klondike River Watershed – Summary**

The Klondike River Watershed was once again designated a ‘watershed of interest’ for monitoring in 2016 as it likely will remain for many more years to come.

Seven automatic water-sampling stations, three portable weather-monitoring stations and three level logger sites were set up and maintained from May 19, 2016 until shutdown on September 8, 2016. Water sampling sites in the Klondike received multiple visits during the monitoring season owing to their close proximity to Dawson.

From the data obtained by these instruments and through on site visits and sampling conducted by CMI staff, the following observations regarding the water quality in the basin can be made:

At the four Klondike River main stem sites monitored during the 2016 season, the water quality of the Klondike River, met the minimum objectives set under the *Fish Habitat Management System* 70% of the time. The water quality of the North Klondike River, met the minimum objectives set under the Fish Habitat Management System 77% of the time.

Out of the 367 water samples collected on 3 tributaries to the Klondike River, the water quality met the minimum objectives set under the *Fish Habitat Management System* 42% of the time. These four sites were monitored with automated equipment during the 2016 season. Most of the exceedances of the WQO were recorded at Hunker and Bonanza Creeks with the majority on Hunker Creek at the highway crossing, below all mining.

On those occasions when the WQO were not met and the Total Suspended Solids levels were greater than the objectives, a direct correlation between environmental conditions and the volume of solids in the water was observed. In most cases, rainfall, as either localized events or basin wide occurrences, increased the amount of surface run off and subsequent soil erosion from the land, increasing the input of sediment into the receiving waters. These increases occurred simultaneously at the time of the rain event or immediately in a period of one or two days after the rain event, as surface water continued draining from the land and ground water infiltrated the watercourse.

Increases in sediment-laden ground and surface water entering the system add to the amount of sediment in the water. The ability of the receiving water to dilute these inputs of sediment is negated by the re-suspension of streambed material and by the further erosion of the streams banks that occurs along with the increased flows that are generated by the aftermath of these rain events.

## **Water Quality Objective monitoring, Klondike River Watershed – Summary Cont.**

A heavy, fast running spring freshet and several major precipitation events lead to increased flows and sediment input as well as the re-suspension and further erosion of stream bed & bank material. The increased volume of flow provided additional dilution and there was a slight increase in the overall water quality for the Klondike River in 2016. The seasonal average Total Suspended Solids (TSS) of the Klondike River in 2016 was 22.4 mg/L, which is 0.8 mg/L lower than in 2015 when on average was running at 23.2 mg/L.

At the Hunker Creek site below all mining (KL\_HU01), the TSS analysis was usually above the WQO of 80 mg/L. On average, the site had a TSS concentration of 309.4 mg/L. After Hunker creek passes under the highway through culverts, it drains into a short straight 100-meter channel, which then discharges wetland, eventually draining through three distinct channels and several indistinct points into the Klondike River. Between the highway and the Klondike River, more than 82% of the solids settled out in this braided wetland area before entering the receiving waters of the Klondike. The average discharge directly into the Klondike River from these multiple point and non-point sources was 56.7 mg/L, well below the water quality objective of 80 mg/L.

The Fish Habitat Management System - Klondike River Watershed (Category A)  
 Sample Results that Exceed Water Quality Objectives for 2016

Sampling Station Location Description	KL01 Mouth	KL_BO01 BAW	KL02 u/s KL_BO01	KL_HU01 AT HWY XING BAW	KL_HU01C KLONDIKE CONFL. Mouth	KL03 u/s KL_HU01	KL05 at Dempster Hwy	KL_NK01 u/s of Klondike R	KL_FL01 Mouth
Sample Type	Auto/Grab	Auto/Grab	Auto/Grab	Auto/Grab	Auto/Grab	Grab	Auto/Grab	Auto/Grab	Auto/Grab
Lat Y	64.05348	64.04054	64.04237	64.02943	64.03382	64.03529	63.99030	64.00195	63.94316
Long X	-138.43981	-138.40414	-138.37867	-138.40959	-138.29634	-138.29009	-138.29622	-138.29622	-138.29622
Habitat Classification	Area of special consideration	Medium-L	Area of special consideration	Medium-L	Medium-L	High	High	High	Medium-L
Water Quality Objective (mg/L)	25	80	25	80	80	25	25	25	80
Date of Sampling									
19-May-16							27.2	0.0	44.3
20-May-16	19.6	11.6	36.8	89.6				8.8	69.2
21-May-16		12.8	14.4	134.4				14.4	72.0
22-May-16		168.4	29.6	1796.4				128.4	128.4
23-May-16		65.0	210.8	827.6				191.2	85.8
24-May-16		27.2	152.4	396.0				61.6	99.6
25-May-16		16.4	69.6	138.4				39.2	56.2
26-May-16		4.0	56.8	161.8				33.6	32.8
27-May-16		2.0	48.4	56.4				15.6	30.8
28-May-16		47.6	35.6	54.0				16.0	27.6
29-May-16		4.4	34.0	43.6				9.6	31.6
3-Jun-16		123.6	20.0	357.6				28.0	16.8
4-Jun-16		456.4	82.4	6876.0				75.8	391.8
5-Jun-16		302.0	146.0	2048.0				88.4	347.2
6-Jun-16		59.2	150.8	993.6				79.2	302.4
7-Jun-16		1417.6	254.8	855.6				68.8	635.6
8-Jun-16		54.0	272.0	559.6				32.8	787.2
9-Jun-16		34.4	111.6	355.6				34.8	210.8
10-Jun-16		32.8	54.8	124.0				48.0	90.0
11-Jun-16		26.8	156.0	53.6				41.2	63.2
12-Jun-16		47.6	50.0	120.4				31.6	88.8
13-Jun-16		59.6	21.6	108.4					
14-Jun-16	36.0	836.7	25.2	1576.0			30.4	47.6	57.2
15-Jun-16	64.0	230.0	45.6	571.6			51.2	85.2	124.4
16-Jun-16		68.4	47.6	133.6	18.8	32.0	41.6	42.8	60.4
17-Jun-16		60.8	51.2	104.4			42.0	24.8	50.4
18-Jun-16		29.6	33.6	73.2			37.6	24.8	39.8
19-Jun-16		23.6	23.6	66.8			52.4	29.8	20.4
20-Jun-16		21.2	39.6	77.6			29.6	28.8	24.8
21-Jun-16		31.2	23.2	94.8			18.0	15.6	10.0
22-Jun-16		26.8	16.4	84.0			12.4	15.2	16.4
23-Jun-16		35.0	14.8	64.4			28.4	7.2	4.8
1-Jul-16		55.6	6.4	174.8			11.2	23.2	10.4
2-Jul-16		37.2	12.4	718.4			30.0	10.8	16.4
3-Jul-16		22.4	22.4	234.0			10.4	22.8	12.4
4-Jul-16		27.2	7.2	142.0			18.4	7.2	17.6
5-Jul-16		26.4	18.0	168.8			21.2	16.0	19.6
6-Jul-16	9.6	14.8	9.2	126.8	47.2	12.0	10.8	1.6	20.4
7-Jul-16	11.6	185.2	5.2	68.4	26.0		5.6	12.0	13.8
8-Jul-16		109.2	3.6	125.2	27.6		14.8	29.0	12.4
9-Jul-16		57.2	2.0	489.6	37.6		5.2	12.8	18.0
10-Jul-16		108.0	4.4	174.4	78.4		6.8	14.0	12.0
11-Jul-16		47.6	33.6	121.6	42.0		9.6	9.2	20.4
12-Jul-16		59.2	2.0	79.6	29.2		9.2	14.0	23.6
13-Jul-16		256.8	5.6	48.0	23.6		5.6	10.4	53.6
14-Jul-16		113.2	4.4	112.4	16.8		5.2	18.4	22.0
15-Jul-16		101.6	2.4	106.0	2.4		4.8	8.8	14.0
16-Jul-16		58.4	0.8	42.8	26.8		2.8	11.2	30.4
17-Jul-16		59.6	2.4	50.8	16.8		3.2	9.2	17.2
18-Jul-16		27.6	6.0	56.4	5.6		2.8	12.8	24.4
19-Jul-16		16.0	4.4	42.8	5.8		5.4	30.0	5.0
20-Jul-16		26.0	2.8	54.4	11.6		4.4	8.4	12.4
21-Jul-16		22.0	6.0	34.8	8.8		10.0	10.8	4.4
22-Jul-16		201.6	2.4	253.2	18.4		9.6	14.4	17.2
23-Jul-16		210.4	4.4	665.6			20.0	17.2	30.0
24-Jul-16		68.0	12.0	182.4	50.4		21.2	26.4	129.2
25-Jul-16		698.8	18.8	410.8	59.6		27.2	19.2	77.6
26-Jul-16	12.0	217.2	32.4	237.6	213.2		53.2	10.0	132.2
27-Jul-16		74.8	24.4	502.0	137.5		36.0	6.8	92.4
28-Jul-16	3.6	78.0	24.8	219.2	52.0	3.2	29.2	5.2	27.2
29-Jul-16		225.6	4.4	100.4	54.0		23.2	9.6	49.2
30-Jul-16		70.0	2.8	157.2	54.4		13.4	7.2	41.2
31-Jul-16		85.2	12.0	70.8	41.2		18.0	2.0	15.6
1-Aug-16		78.4	4.4	51.2	48.4		10.0	4.0	20.4
2-Aug-16		83.6	3.2	83.6	51.2		11.8	12.4	29.2
3-Aug-16		58.8	9.2	67.6	38.4		7.6	5.8	19.2
4-Aug-16		18.0	6.8	40.0	28.4		8.4	6.8	26.8
5-Aug-16		124.0	4.0	97.6	46.8		7.2	6.4	28.4
6-Aug-16		376.8	6.4	426.4			16.0	15.2	127.2
7-Aug-16		109.2	1.6	175.2	51.6		16.8	10.4	168.0
8-Aug-16		101.6	4.4	182.4	72.0		20.4	5.6	96.8
9-Aug-16		110.4	4.8	71.2	38.8		7.6	11.6	53.6
10-Aug-16		2278.0	100.8	1107.2	308.4		258.8	61.2	629.2
11-Aug-16		387.6	274.4	1111.6	207.2		195.6	223.2	597.2
12-Aug-16		147.6	629.2	101.6	108.0		108.0	50.8	377.2
13-Aug-16		107.2	76.8	266.8	41.2		50.4	53.6	131.2
14-Aug-16		77.2	50.0	180.8	50.0		38.4	20.0	93.2
15-Aug-16		266.0	27.2	147.2	88.0		34.0	24.0	71.6
16-Aug-16		274.0	41.2	469.6	115.6		40.8	22.0	57.6
17-Aug-16		63.2	34.4	347.6	82.4		20.4	9.2	56.4
18-Aug-16	10.0	116.0	9.6	159.6	69.0		25.6	12.0	55.2
19-Aug-16	5.6	115.6	18.4	182.4	79.2	2.0	7.6	12.8	31.6
20-Aug-16		90.8	16.0	225.2	69.6		16.0	10.8	7.2
21-Aug-16		40.0	10.8	109.8	130.0		6.4	10.4	18.0
22-Aug-16		68.4	2.8	264.4	77.6		9.2	7.2	30.0
23-Aug-16		66.8	5.2	112.8	37.6		20.8	7.6	23.6
24-Aug-16		34.0	2.8	191.2	56.4		2.8	7.2	14.8
25-Aug-16		73.2	5.2	296.4			14.0	6.4	16.4
26-Aug-16		248.8	15.2	688.8			71.6	18.4	120.8
27-Aug-16		190.4	36.0	163.6			46.0	4.0	172.8
28-Aug-16		89.6	9.6	281.2	59.6		3.2	9.2	88.4
29-Aug-16		47.2	2.8	82.0	39.2		12.8	8.4	51.2
30-Aug-16		29.2	1.6	50.4	39.6		6.0	10.4	19.2
31-Aug-16		23.2	0.8	82.0	33.2		6.8	1.2	12.4
1-Sep-16		29.2	1.6	46.0	26.0		4.4	8.0	10.4
2-Sep-16		61.2	1.2	163.8	17.6		9.6	4.8	17.6
3-Sep-16		94.8	2.0	156.8			11.2	16.4	7.6
4-Sep-16		107.2	0.8	78.8	22.4		2.8	1.6	8.8
5-Sep-16		39.2	4.8	17.2	13.2		4.0	2.8	6.8
6-Sep-16		89.6	3.2	61.6	15.6		6.0	7.6	9.2
7-Sep-16	50.0	963.2	5.2	562.4			14.4	21.2	8.0
8-Sep-16	20.4	480.8		340.4	90.8	11.6			20.4
Total Seasonal Average TSS (mg/L) by site	22.0	130.6	32.0	309.4	56.7	12.2	23.4	22.8	73.1
Number of days sampled	11	112	111	112	61	5	87	111	112

Legend

Not continuously monitored  
 Water Samples that are: Above / Below the Water Quality Objective